INERTIAL CONFINEMENT FUSION
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Bimonthly Update

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Activation of the 4ω Thomson Scattering Probe on the OMEGA Laser

In collaboration with the Laboratory for Laser Energetics (LLE), we have commissioned a new high-energy Thomson scattering probe beam on the LLE OMEGA laser, operating at 236.5 nm (4ω). A large 300-mm-aperture KDP quadrupling crystal was successfully installed and tuned to convert up to 70% of a pre-existing 2ω probe beam to 4ω. When operating at full energy the 4ω probe produces more than 250 J on target in a 1-ns pulse. This energy exceeds other UV probes on the Nova and Vulcan facilities by factors of 3 and 5 respectively.

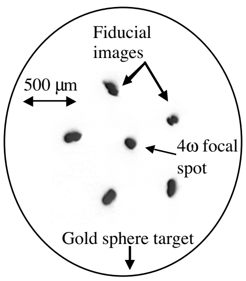

Figure 1. An x-ray image of 4ω focal spot. The five 3ω beams surrounding the 4ω probe spot are used as a pointing fiducial.

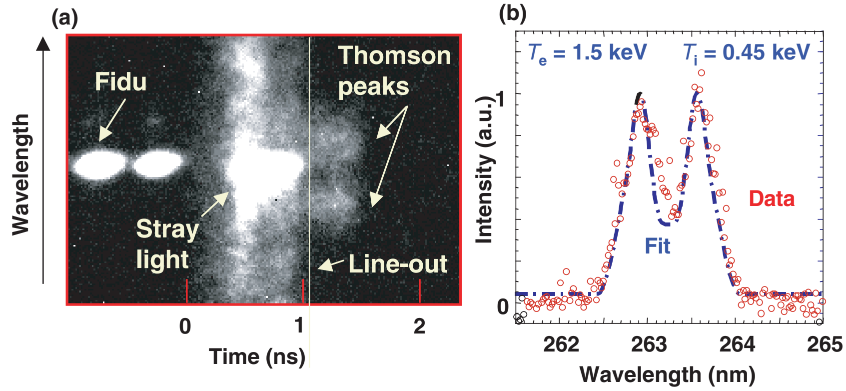

Figure 2. (a) A 4ω streaked Thomson scattering spectrum from a neopentane gasbag. (b) Theoretical Thomson fit to spectra from neopentane gasbag, giving an electron temperature of 1.5 keV.

Figure 1 shows an x-ray image of the 4ω probe focused to a minimum spot size of 50 μm. The high-power, short-wavelength beam is optimal as a penetrating but noninvasive probe of localized densities and temperatures of NIF-relevant laser plasmas using the technique of Thomson scattering. The scattered light is collected using an f/10 lens and transported via an optical system to a streaked spectrometer. High-quality Thomson scatter data were obtained in a number of collaborative laser–plasma experiments in hohlraums, planar discs, and gasbags. Figure 2a shows a streaked Thomson scattering spectrum from a neopentane-filled gasbag. From the separation of the two features shifted by the ion-acoustic frequency either side of the central probe wavelength, we infer a peak temperature of 3 keV in krypton gasbags and 1.5 keV in neopentane. This new capability will be used as a routine temperature and plasma wave diagnostic on OMEGA experiments.

Dynamic Hohlraum Experiments

A hohlraum (radiation cavity) is usually thought of as a cavity with rigid, high-Z walls that are opaque to x-rays. Another class of hohlraums is the "dynamic" hohlraums described by Matzen et al. (*Physics of Plasmas* **4**, 1519 [1997]). In the version used on the Sandia Z machine, hohlraums are generated by an array of high-Z wires, and change both their size and their opacity to x-ray drive as a function of time. A laser-driven analog of this has been created using the OMEGA laser. Forty beams of OMEGA are incident on a 20-μm-thin walled capsule filled with 1.5 atm Xe gas (Figure 1). A shock is driven in the Xe, which radiates so strongly that it collapses to a thin dense layer. This dense Xe layer is opaque to radiation, and functions as a hohlraum wall. A streaked x-ray radiograph is generated by 10 of the remaining beams (Figure 2). Initially a low level of signal may be seen due to the self-emission of the plastic. Later in time, the radiography beams are turned on, and the capsule wall and the thin, dense, shock in the Xe may be seen as dark shadows. The two are separated by a transmitting region of plastic heated to low density by the radiating shock. This technique has potential applications as an x-ray source for radiography and probing, and as a driver for opacity and implosion experiments. This work was done in collaboration with the Defense and Nuclear Technologies Directorate.

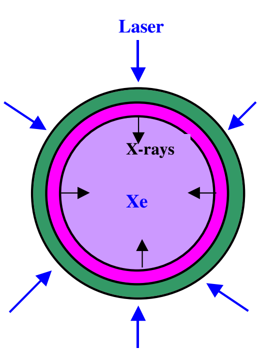

Figure 1. Experimental geometry.

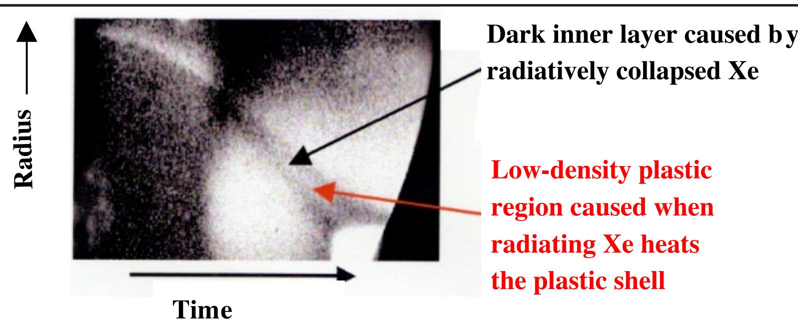

Figure 2. Streaked x-ray radiograph.

For comments about content of the ***Bimonthly Update,*** contact Bruce A. Hammel (925) 422-3299.
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